OBSERVATIONS ON THE AETIOLOGY OF TRACHOMA.

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Observations on the AEtiology of Trachoma.

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I. INTRODUCTION.

Importance of the Subject.

The importance of a careful consideration of this subject at the present time arises mainly from two different considerations:-

1. The possibility of a spread of Trachoma owing to the increased intermingling of peoples during and after the war.

Without wishing to over-emphasise the danger, one must recognise the possibility of this spread. It should be remembered that troops have been engaged in areas which are hot-beds of Trachoma, and that men suffering from Trachoma have served in the different armies. Also there is the danger that countries whose trade recovers first from post-war depression will be invaded by intending immigrants from Continental Trachoma areas. It is most important that measures should be taken to guard against the entry of trachomatous subjects under such Acts as (I) the Aliens Act of Great Britain, 1905; or (II) the Canadian Immigration Act Amendment. 1902.[1][2] And in order to carry this out efficiently an understanding of the aetiology of Trachoma is certainly desirable. Without it there is a great risk of infecting new areas with Trachoma or of inflicting unnecessary hardship upon harmless individuals.

As in the 18th and 19th centuries, Trachoma is still one of the great menaces known to mankind, meaning loss of education, loss of working capacity, subsequent dependence on public funds owing to partial or total blindness, or at any rate a state of contagiousness lasting over a long period of time.

2. The hopefulness of prophylaxis once the aetiology is definitely understood. There is as much scope for satisfactory results in the prevention of Trachoma as there has been in the case of enteric fever by vaccines and in the case of malaria by anti-mosquito measures.

Prophylaxis of ophthalmia neonatorum has produced gratifying results. It would probably be even more so in the case of Trachoma. With regard to Egypt and India, could Britain bestow freedom from Trachoma it might prove one of the most beneficial acts of that country's government. It is doubtful whether in any other field of Ophthalmology results are so near at hand. There may be as good a prospect in the subject of phlyctenular disease, but Trachoma is of more widespread importance.

Definition of Subject.

The word Trachoma is derived from the Greek τραχὺς meaning rough, uneven; so called from the character of the conjunctiva. The term was first employed by Pedanius Discorides in 60 A.D. though not in the specific sense in which it is used to-day.

In later times dating from Buonaparte's expedition to Egypt in 1798, new terms for the disease arose, e.g. ophthalmia, ophthalmia purulenta chronica, ophthalmia militaris seu bellica, conjunctivitis granulosa. Then the name Trachoma came into general use about the middle of the 19th century.

Trachoma may be defined as a specific contagious form of conjunctivitis, extremely chronic, lasting months and often years, and when left to itself causing

serious and permanent impairment of vision, and frequently even total blindness.

In the early part of the last century very little was known of the pathological anatomy, and the various forms in which military ophthalmia appeared were never analysed clinically or microscopically. Acute catarrhal conjunctivitis, gonorrhoeal ophthalmia and Trachoma were frequently confused by observers. Later the papillary and the granular forms of Trachoma were regarded as different diseases, and cases where the two kinds of changes were evident were called Trachoma mixtum. Gradually it came to be seen from microscopical examination, that practically all cases show the changes known as mixed Trachoma.

Then within the last thirty years the infectious nature of the disease has become fully recognised and attempts have been made to discover the infective agent.

Object of Thesis.

The purpose of the present thesis is to give an account of the growth of theories as to the aetiology of Trachoma together with the most recent work on the subject, and also to record the results of personal investigations.

II. HISTORICAL OUTLINE.

In order to make an investigation into the aetiology of Trachoma, it is necessary to consider first of all what is known of its origin and the ways in which it has spread.

The following are the chief facts in the history of the disease arranged chronologically:-

Early History.

1553-1550 B.C.

Most observers regard Egypt as the birth-place of Trachoma. The earliest reference is found in the Ebers Papyrus. From this compilation with its prescriptions for various diseases, Ebers proved that during the height of Egyptian civilisation, "Watery eye" or "blear eye", was a well recognised condition and that in all probability this was Trachoma. There is no evidence however that the Egyptians suffered from it to such a great extent as in later times.

405 B.C. Aristophanes in "The Frogs" alludes to ophthalmia as an excuse for evading marine service.

388 B.C. During the siege of Athens Trachoma became prevalent and Aristophanes deals with its treatment in the play "Plutus". About the same time Plato in the "Phaedrus" alludes to this contagious ophthalmia.

43 B.C. - 17 A.D.

Ovid writes of the contagiousness of ophthalmia.

3 B.C. - 65 A.D.

Seneca also mentions this point.

20 A.D. Cornelius Celsus writes of the chronicity and intermissions of Trachoma, his term for the disease being "aspritudo".

23 - 79 A.D.

The Elder Pliny describes it as "lippitudo".

43 A.D. Scribonius Largus also uses this term.

60. Pedanius Discorides uses the term Trachoma for the first time.

50-120. Plutarch mentions the virulence and the frequency of contagion of ophthalmia.

130-200. The writings of Galen contain several references to the remedies for "τραχωματικὰ". Two anonymous manuscripts, the "περὶ ὄψιος" and the "Isagoge", describe different stages of Trachoma and the friction treatment respectively.

380. Marcellus.
447. Cassius.
540. Aetius.

All give accounts of Trachoma.

From the foregoing details it is seen that the disease Trachoma and its contagiousness were well recognised among the Egyptians, Greeks and Romans.

There is no positive proof as yet that Trachoma was known in India and China in ancient times.

700 A.D. Myjashita states that in Japan, Trachoma was known at this period.

900. Isaac Judaeus, an Arabian oculist in Egypt describes Trachomatous pannus.

1030. Avicenna gives a similar description.

1200. Benvenutus Graphaeus describes friction treatment, excision of granulations and also describes the Eastern Shore of the Mediterranean as the part where Trachoma was most frequently found.

1350. A description of Trachoma given by Guy de Chauliac.

1481. 1488. Jewish travellers state that most of the inhabitants of Egypt suffered from eye disease.

1540. Ambroise Paré, the pioneer French surgeon, makes brief mention of Trachoma under the term Asperitudo.

1561. Franco describes Pannus.

1583. Bartisch in his "ὀφθαλμοδουλεία", the first German book on diseases of the eye, describes Pannus in Trachoma.

1584. Prosper Alpinus of Venice finds the disease rampant in Cairo.

E P I D E M I C S.

1699-1701. An epidemic occurred at Breslau in Silesia.

1701. An epidemic probably of Trachoma occurred in Ireland. At that time it was commonly called "Mulberry Eyelid".

1722. St. Yves and Maitre Jean of Paris described the disease as scabs of the eyelids.

1761. An epidemic occurred among British Troops in Westphalia. About the same time Amatus Lusitanus wrote of Trachoma occurring in Spain and Portugal, and Forestus found it in Holland.

1788. Penada describes an epidemic of ophthalmia at Padua.

1792. Beer described Trachoma in a book on diseases of the eye, and later described entropion and trichiasis as its sequelae.

1798-1801. This was the date of the Napoleonic Expedition to Egypt. An epidemic of a mild character occurred in the French army in 1798, and in 1801 quite two thirds of the army were suffering severely from Trachoma.

1799. A severe epidemic occurred among troops on the lower Rhine.

1800. Almost all the English troops landed in Egypt were attacked by ophthalmia, some cases being gonorrhoeal and some Trachoma.

1801. The disease became more extensive in Italy after the visit of the French troops on their way from Egypt, and town after town became infected by the Italian troops.

1803. Power wrote of epidemic ophthalmia in Ireland that it was a species of the same disease as Egyptian ophthalmia.

1804. Trachoma appeared in England, spreading through most units of the army.

1805&6. In one battalion of the English army there were 636 cases out of about 700 men in one year, 50 men losing both eyes, and 40 losing one eye.

1809. An epidemic occurred among Italian troops in Hungary.

1810. A committee was appointed to draw up recommendations for prevention and treatment of the disease in the British Army.

Some of its suggestions were:-

1. Segregation of cases.
2. Separate towel and water for washing purposes.
3. Frequent washing of bedding and clothing.

1811. The surgeon to the British Military Asylum reported that 2,317 soldiers were dependent on the public owing to loss of vision in both eyes from ophthalmia.

1813. The Prussian Army became infected with Trachoma from the Russian and Prussian Baltic Provinces. Evidence tends to show that this epidemic was independent of any infection from Egypt. The disease was endemic in the Baltic Provinces before invasion by the French.

1813-15. From the Prussian Army the disease seems to have spread to the Swedish Army which had served in Germany, but there is evidence that Trachoma was endemic in Sweden and Finland before this time.

1815-1825. Trachoma became common in the Dutch and Belgian Armies.

1818. A fresh outbreak occurred in the Prussian Army owing to enrolment of trachomatous recruits from the lower Rhine.

1817-1826. Epidemics among Italian troops at Leghorn, Palermo, and Catania.

1818. Trachoma began in the Russian army among troops stationed at Warsaw.

1819-23. The Russian troops at Cronstadt and St. Petersburg became affected.

1831. During the Russo Polish war Trachoma gained a firm footing in the Russian army.

1833-4. Second epidemic in the Austrian Army with 920 cases and traced with considerable degree of certainty to infection from one particular soldier.

1833. Lawrence gave the opinion that Trachoma had existed in England before infection from Egypt.

1834. Over 4,000 trachomatous cases from the Belgian Army were dispersed to their homes with disastrous results as regards spread of the disease among the civil population. Those responsible for the dispersal denied the contagiousness of the disease.

1839. Fuchs states that up to this year the number who had suffered from Trachoma in the Russian army was nearly 77,000 of whom 654 were blind in both eyes, and 878 in one eye.

1848. Trachoma began in the Danish army owing to infection from German troops.

1849-1850. Epidemic of Trachoma in Workhouses in Ireland.

1849-1851. Third epidemic in Austrian Army and spread of Trachoma through the civil population.

1849-1859. 10,000 cases occurred in the Portuguese Army in these years.

1854. British and French troops at Gallipoli in the Crimean War were affected with Trachoma.

1882-3. An epidemic occurred among British troops in Cairo after the Battle of Tel-el-Kebir.

Admissions to Hospital in British Army owing to Trachoma.

1837-46... ... About 8% of troops.

1861-67... ... About 4% of troops.

1896-1902. ... From 3 - 10 cases annually.

S C H O O L S.

1875. Nettleship[3] found Trachoma common among London Poor Law school children, 42%.

1897. Stephenson[4] found under 5% of London Poor Law school children suffering from Trachoma after a policy of isolation of Trachoma cases.

Legislative Action.

1899. - U.S.A. Government prohibited aliens suffering from Trachoma from entering the country. 1 in 1000 emigrants were excluded during the year.

1900. 1 in 1500 emigrants excluded.

1901. 1 in 2100 emigrants excluded.

History shows that it is only gradually that true Trachoma has become differentiated from catarrhal, follicular and gonorrhoeal conjunctivitis, classed together as ophthalmia.

III. EARLY VIEWS ON AETIOLOGY.

I. The question of contagiousness.

While the contagiousness of Trachoma has been recognised from the earliest times, it has not always been admitted by all. At intervals opinion in the past has been divided.

There have been the "contagionists", and the "anticontagionists".

A. Among the former may be mentioned:-

1. The Greeks, Plato and Plutarch, and the Romans, Ovid and Seneca.
2. Probably the first physicians to put forward a theory of contagiousness were the Arabians, Avicenna and Moyses.
3. In this country since Trachoma was first recognised, its contagiousness has been strongly urged. In 1803 Power, writing of the Irish epidemics expressed this opinion as also did Vetch(5) in 1807 and the Commander-in-Chief's Committee in 1810, with regard to Army Trachoma.
4. In Germany, opinion has been divided. About 1820 Rust(6) together with C.F.Graefe(7), and others, maintained that the cause was a communicable virus.
5. In 1841 after the epidemic in Belgium, following the dispersal of trachomatous soldiers, Deconde(8) in reporting on it recognised the contagiousness.

B. Those who were most prominent in maintaining the non-contagious character of Trachoma were:-

1. Larrey,(9) who voiced French opinion in 1803.
2. Baltz,(10) the German, who regarded the disease as of spontaneous miasmic origin under unfavourable war conditions.

3. Vleminckx, who was partly responsible for the dispersal of trachomatous soldiers from the Belgian Army.
4. Mutermilch,[11] Vennemann of Louvain, Gunning of Amsterdam, Swan Burnett[12] of Washington, regarded its contagiousness as not proved.

The negative results of certain inoculation experiments might be taken to support the theory of "no contagion". Piringer, Mackesy, Adams, Baeck,[13] among others, made inoculation experiments with negative results.

On the other hand, Werneck in 1823 successfully inoculated two patients with Trachoma after an incubation period of nine and fourteen days. Van Millingen was able to produce Trachoma by instilling trachomatous secretion into normal conjunctival sacs, while he was unsuccessful when using Trachomatous tissue. At the White Oak Ophthalmia School in Kent,[14] two attendants contracted Trachoma in 1903, and in one case there was a history of water splashing into the eye, while a trachomatous child was being washed, the symptoms of Trachoma in the attendant following after this. Addario and Greef[15] report that transfer of trachomatous secretion to a normal conjunctiva has resulted in development of Trachoma. Chibret found on enquiry among French ophthalmologists in 1896, that all admitted the contagiousness of the disease, and that view represents the consensus of modern opinion. Where the soil is suitable contagion produces the disease.

II. The development of theories as to the cause.

Some views of causation held during the early part of the nineteenth century were[16]:-

Fine prickles of cactus plant in the air.

Prickles of Fillaria Papillosa in the air.

Nitrous particles entering the eyes.

Chalky " " " "

Muriatic fumes in the air especially along warm sea coasts.

Metastasis from catarrh elsewhere in the body.

" " Typhoid.

" " Dermatitis.

Metastasis from Scrofula. According to Swan Burnett.[17] (1876) Trachoma is not a simple local disease, due directly to a specific infection by a special germ from the outside, but is the local manifestation of a Dyscrasia. Fallot (1838) states that it bears a resemblance to Tubercle without being identical. Both are deposits of developments of foreign material in the tissue which leads to its destruction and the formation of contracting cicatrices.

Gonorrhoea. Several authors have regarded the disease as secondary to gonorrhoea, and more recently suggestions have been made as to a close relationship between the two conditions. These will be referred to in a later section.

Syphilis.

The glare of light.

Compression of neck by tunics and excess of blood to the head.

Dust.

Close cropped hair.

Previous Blenorrhoea

Bad sanitary conditions.

Exhalations of people crowded together.

Sudden chills.

Changeable weather, and Miasmata.

Too rapid healing of ulcers and wounds.

Fatigue of war.

Diminution of secretion in the lower parts of the body, intestine, bladder and urethra.

Rust and Graefe held that the chief factor was a virus, which was constantly being renewed by the disease itself.

It is this last view that has steadily gained ground. Gradually the modern view has been evolved that the exciting cause of Trachoma is probably a micro-organism, which is present in the trachomatous secretion.

III. The mode of transmission.

This is the third point about which there has been much controversy from early times. The theories are:-

A. Air Transmission.

The earliest opinion as to the mode of spread is that of the Arabians who believed that Trachoma might be acquired by looking at an affected eye. This view of air transmission was confirmed at the Brussels Ophthalmological Congress in 1857, and again by A. von Graefe and by von Arlt. In 1890 Sulzer of Java maintained that air infection was the common mode of transmission. Schmidt-Rimpler states that in Egypt Trachoma may be conveyed by air. Against these statements may be placed evidence produced by Stephenson(18) from Hanwell Ophthalmic School. In five years not one of the servants, 65 nurses, or 16 teachers was attacked by Trachoma. "Had it been capable of transmission through the air it must surely, according to the law of averages, have affected many of these exposed individuals. The preventive measures have been based on the theory

that contagion is by direct or indirect conveyance from eye to eye."

B. Dust Transmission.

Sulzer of Java favours the theory of dust transmission, stating that in the Dutch colonial army dust was often the medium of contagion.

Germann suggests that the organism grows in the soil. Hirschberg considers it may grow in standing water.

Kuhnt agrees with both, stating that when pools dry up in warm weather fresh cases of Trachoma are seen, accompanied by nasal secretion, such as would follow dust irritation. There seems to be no proof as yet that dust does more than increase discharge, and increase infectivity.

C. Infected Rooms and Utensils.

Förster, (1890) maintained that Trachoma was spread by contagion adhering to the walls of a room. Vossius also maintained that cases occur when people occupy infected quarters after Trachoma patients have left, and fresh cases cease when proper cleansing has been carried out. There is no further proof as to this mode of transmission.

At the Brussels Conference in 1857, it was pointed out that contagion might occur by contaminated utensils.

D. The Discharge.

The view which has gradually come to be the accepted one, is that the discharge conveys the virus, and that direct or indirect contact with the moist secretion for some time is likely to cause transmission of the disease. This may

take place by spurting of discharge or by fingers, towels, basins, handkerchiefs, clothing, bedding, doors, etc. The lids and lashes are first reached, and thence the conjunctiva is infected.

IV. FACTORS CONCERNED IN PRODUCING THE DISEASE.

It became recognised that Trachoma was due to some virus. In order, however, to explain the frequency and infrequency of spread under varying conditions it was held that the presence of a predisposing cause was also necessary. Trachoma was produced when the virus acted on a suitable or prepared soil. The chief factors considered to have a predisposing influence in Trachoma have been:-

A. RACE.

It was recognised that certain nations enjoy a great measure of freedom from Trachoma, while others show a high percentage of cases. Certain writers have maintained that this is due to a racial insusceptibility or susceptibility.

1. 1876. Swan Burnett claimed immunity from Trachoma in the case of the United States negroes. The Irish, Jews, Italians and Teutons were all very liable to the disease. The Chinese and American Indians suffered also. But in 10,000 eye cases in negroes Burnett found only six cases suspicious of Trachoma.

2. 1896. Berger held that the Aryan races were less susceptible than the Semitic and that the least susceptible were French Celts.

3. 1896. Chibret believed in racial predisposition and enunciated a law:-
"The Trachoma Virus, which is only slightly virulent for Celts, loses all virulence for that race after transmission through a Celt."

4. 1899. Yarr[19] divided races into three groups:-

(a) The susceptible:- Among these were the Irish, Jews, Poles, Italians, Chinese and Japanese.

(b) The relatively immune:-
United States Negroes.
West African Negroes.
Singhalese.

(c) The absolutely immune:-
Eskimos, Canadian Indians, and the Crees of Manitoba, who live near the susceptible Russian Menonites.

According to these authorities, race is the predominant factor in predisposition.

Against the above views there are these facts:-

1. As de Gouvea pointed out, while the negroes of U.S.A. suffer little from Trachoma, the same race in South America, South Africa, and Egypt suffers greatly.

It may be that the negroes in the States do not mix so freely with the whites, and are therefore not so liable to infection.

2. It seems unreasonable to claim immunity for Celts when the Irish are so susceptible to Trachoma. Trachoma cases form 3% of eye cases at a Dublin Hospital.

One must admit that Trachoma is more common among certain races than others, but from the foregoing record of the arguments, it seems unlikely that the reason is a racial predisposition. Other predisposing factors are probably much more important.

In 1912 at the Fuchs clinic in Vienna, I noticed what is a well-known fact, that the majority of the Trachoma cases seemed to belong to the Jewish race, and at Manchester this year I have noticed that

many Jews attend the hospital for Trachoma. But among the more cultured Jews, for instance in Hungary, Trachoma is said to be rare.

B. GEOGRAPHICAL CONDITIONS.

Though the geographical distribution of Trachoma has only been studied carefully during the last twenty five years, it has become clear that Trachoma is world wide in its distribution. With the possible exceptions of the extreme north and south, where Eskimos for example are not affected Trachoma exists at least sporadically all over the world. In some countries it is more prevalent. Among European countries Russia, Poland, Austria, Hungary, Bulgaria, Rumania, Italy, Spain, Portugal, Finland, Belgium, Greece, Germany and Ireland all have large numbers of Trachoma cases, The actual statistics are unobtainable because many cases go untreated. Fuchs states that probably not a single person among the poorer classes in Lower Egypt remains free from Trachoma. One author states that figures given for different countries vary from the low decimal percentage of Great Britain and Switzerland to 90% for Central Asia. Arabia, Syria, Persia, China, Japan, India, are all over-run with Trachoma, while Australia and New Zealand are not free.

But after recognising the wide distribution of Trachoma, writers have maintained that certain geographical conditions tend to influence its spread.

Raehlmann(20) maintained that humidity of climate helped the spread of Trachoma, because the discharge retains its virulence amid dampness. He gave this as a reason for the frequency of Trachoma in low lying

country near rivers, coasts, and marshes.

Another reason why Trachoma is often rife in deltas such as those of the Nile, Rhine, Rhone, Danube, Amazon, Euphrates and Tigris may be that commercial intercourse between peoples takes place chiefly in these areas.

Feuer came to the conclusion that a sandy region was conducive to the spread of Trachoma simply in that it caused more irritation of the conjunctiva giving more chance of infection from dirty fingers.

Ziehm[21] considered that dusty country and marshy land each produced a different variety of Trachoma.

Elze[22] considered that Trachoma was most commonly found in malarial districts.

Hourmouziades[23] propounded a theory that Trachoma becomes less common as one proceeds from south to north. The frequency of Trachoma in countries such as Finland and Siberia seems at once to disprove this.

Chibret stated that Trachoma does not spread at an altitude 200 metres above sea level. He probably thought of Switzerland, which is comparatively free. But this statement is not correct as Trachoma is rife in the Caucasus.

In Vienna I noticed that many Trachoma cases came from Galicia, which is certainly considered to be the most infected part of Austria.

During three years in Travancore, South India, I noticed that Trachoma was more common on the sea-coast than inland. It also seemed to be more common in a town such as Quilon, a port and railway terminus, than in the capital of the state, which was not on the railway nor in such direct touch with the outside world.

The modern view is that geographical conditions are of importance in aetiology only in so far as they help to produce some of the other predisposing causes.

The immunity of Europeans in Egypt is a strong argument against any direct climatic influence.

C. A LOW STATE OF CIVILISATION, WANT OF CLEANLINESS, AND UNFAVOURABLE OCCUPATIONAL CONDITIONS.

It is convenient to group these predisposing causes together as they simply indicate a want of care in avoiding contagion.

A low state of civilisation means curious and unclean customs. A custom such as that of blackening the eyelashes with pigment applied with a feather is very likely to cause a spread of Trachoma, when the same feather is used for a number of people.

Eastern ideas of cleanliness do not conform to the Western doctrine of asepsis. Washing in holy tanks on pilgrimages as Mohammedans and Hindus do is very likely to spread the infection of Trachoma as well as other diseases. Eastern people in washing make a point of swilling out the conjunctival sacs and the mouth.

One concludes that it is these unclean customs which help in spreading Trachoma because it is said that the gipsies of Hungary, who are dirty and not highly civilised, but who live a life apart in the open and do not bathe in tanks, and do not use towels, do not suffer much.

Overcrowding, as for instance on board ship, favours the spread of infection. Safford (24) states that on the long voyages from Italy to South America, on emigrant ships, the Italian government has found it necessary to segregate in a special part of the ship those passengers who are found to be afflicted with Trachoma, even though the countries

to which they are going do not as yet exclude trachomatous immigrants.

On the steamship Oldenburg, arriving at Baltimore in February, 1907, 67 persons from the same compartment were found to be suffering from an inflammatory infection of the eyes of the same general type, due apparently to the presence in their midst of four cases of Trachoma in a state of acute exacerbation. Of these sixty seven, forty eight developed Trachoma, while the remainder recovered quickly.

Lucanus(25) found that Trachoma often spreads by several people sleeping in one bed, and under hospital conditions he was able to keep severe Trachoma cases side by side with non-trachomatous cases without the slightest suspicion of infection occurring.

Occupational conditions may help the spread of Trachoma, both by producing irritation of the conjunctiva as in masons, and miners. and ostlers, and by entailing overcrowding as in the case of farm labourers.

Scott(26) stated that in Egypt almost invariably infection can be traced to direct manual contract. Discharge from the eyes is removed by the fingers, and is transferred to some article, by which it is transmitted to the hands of others.

Feuer(27) stated that Trachoma spreads wherever plenty of opportunity is given for the conveyance of contagion from person to person. Marriage, pilgrimages, intercourse of all kinds, particularly in overcrowded conditions, will in trachomatous districts help to spread the disease.

D. ARMY SERVICE AND WAR CONDITIONS.

In 1900 the incidence of Trachoma in some European armies was as follows:-(28)

Russia...	0.65%
Austria..	0.5%
Italy.	0.184%
Belgium..	0.067%
Germany..	0.05%

Lawrentjew,(29) speaking of the Russian army in 1897, said, "By the infection of unaffected areas by the troops on the one hand, and the introduction of Trachoma by the recruits into the army on the other hand, a vicious circle is formed for which it is very difficult to find a cure."

Thus it is seen that Trachoma may spread in the armies themselves. This was found to take place in the British Army in 1882 by several men washing in the same water, and using the same towel.

Trachoma may also be spread among the civil population by stationing of troops and intercourse between the two communities. Feuer maintained that Trachoma was first introduced into Hungary by the Austro-Hungarian troops stationed on the Turkish frontier.

Sattler(30) held that the distribution of Trachoma was largely determined by the movements of troops. Ebert's(31) conclusion was that military service is not in itself capable of producing Trachoma, but it is highly qualified to favour the causes of growth.

There is little doubt that examples of Lawentjew's two methods of spread have occurred during the late war.

Lister(47) wrote an article for the R.A.M.C.Journal on the problem of preventing the spread of Trachoma.

Troops have been stationed in trachomatous as well as in non-trachomatous areas and the armies themselves have contained trachomatous recruits.

I have invalided from the British Army, men who had not previously been suspected of Trachoma, and who must have suffered severely from the disease when they were recruited.

E. PAUPER SCHOOLS.

There is evidence that these schools do play a part in the spread of Trachoma probably owing to the non-observance of ordinary rules of hygiene in the use of washing utensils and towels. Nettleship in 1874 found 42% of children in London Poor Law Schools suffering from Trachoma.

F. INDIVIDUAL PREDISPOSITION.

Not all persons exposed to infection suffer subsequently from Trachoma. This is a well-known clinical fact, and has given rise to a theory of individual predisposition in Trachoma. Many hold that Trachoma requires very favourable conditions for it to establish itself. Opinions differ as to the nature of the predisposition and also as to its existence.

1. Lucanus did not believe in any individual predisposition.

2. Some writers maintain that the resistance is localised in the conjunctiva.

   (a) Kuhnt[32] considered that an alteration in the chemical composition of the lachrymal secretion might predispose to infection.

   (b) MatKovic[33] held that a diminished alkalinity of the lachrymal secretion might predispose to Trachoma.

   (c) Blumberg[34] suggested that recurrent attacks of conjunctivitis might produce loss of tone and lessened resistance in the connective tissue of the conjunctiva.

3. Other writers consider that the predisposition is constitutional.

(a) Cazalis,[35] Truc, Hourmouziades and Baeck maintained that scrofulous subjects were the most liable to contract Trachoma. By scrofulous subjects they may be taken to mean persons suffering from what would be described as latent tubercle, anaemia, poor nutrition from such causes as insufficient and ill-balanced diet with lack of vitamines.

(b) Blumberg[34] described the predisposing condition as a lack of tone in the connective tissues of the body.

(c) Baeck[13] stated that people who are not predisposed do not take Trachoma even if infected, while the predisposed take it in spite of all attempts to avoid infection. This is obviously an exaggeration.

(d) Von Michel, Raehlmann, and Schmidt-Rimpler stated that severe and obstinate cases of Trachoma occurred in persons who had the scrofulous taint.

A view approaching the truth would seem to be that persons with a lowered general resistance are more likely to contract Trachoma, and that when they do contract it, the disease is apt to run a more severe and obstinate course.

4. <u>PREVIOUS CHRONIC IRRITATIVE DISEASE OF THE EYE.</u>

A person's general health may be good and yet it is possible that the conjunctivae may be so altered by disease as to render them more liable to infection by Trachoma.

1. Alt held that Trachoma originated in a gonorrhoeal ophthalmia.

2. Hummelsheim, Vennemann, and Truc believed that phlyctenular conjunctivitis rendered the eye more susceptible to Trachoma.

3. Peters[36] held that obstinate conjunctivitis and all chronic irritation produced atony and overgrowth of lymphoid tissue in the conjunctiva and a more favourable nidus for Trachoma.

Thus dust, a dry hot climate, smoke, moisture, wind want of sleep, bad ventilation, all predisposed to

Trachoma.

All these causes of irritation of the eye produce not only an unhealthy conjunctiva freely liable to infection but also produce vigorous rubbing of the eyelid and in that way persons might more frequently and more vigorously convey infection to or from the conjunctiva.

After this brief review one is forced to the conclusion that in addition to the exciting cause, there are certain predisposing factors which do influence the incidence of Trachoma. In a later section, reference will be made to cases which forms examples of the various predisposing factors at work.

V. EARLY RESEARCHES INTO THE CHARACTER OF THE EXCITING CAUSE.

The search for the organism of Trachoma began about 1880. The following is a brief summary of the more important results obtained.

A. Cocci found in the conjunctiva.

1881. Sattler found a diplococcus in the discharge and follicles of Trachoma cases. This was obtained in pure culture, resembled the gonococcus but was Gram positive. He claimed to have produced Trachoma by inoculating the organism into the conjunctiva in man and in animals. But inoculation with subsequent generations of the culture did not produce typical Trachoma. Sattler himself thought that the organism might be a variation of the gonococcus.

1883. Koch examined the conjunctival discharge in fifty cases of Trachoma and in some found an organism resembling the gonococcus. These cases evidently were not pure Trachoma but examples of mixed infection as organisms of severe catarrhal conjunctivitis were found as well.

1885. Von Michel[37] found a diplococcus in the discharge and follicles during a school epidemic of Egyptian ophthalmia. On inoculation, however, the condition produced was not typical Trachoma but Follicular Conjunctivitis which ran a mild course and responded readily to simple treatment.

1885. Raehlmann
1886. Poncet, Desormes and other observers discovered micrococci which have proved to be gonococci or pneumococci.

No micrococcus has yet been shown to produce typical Trachoma.

B. Bacilli found in the conjunctiva.

1881. Hirschberg and Krause[38] found bacilli in the conjunctival discharge in acute Trachoma. These were not found in chronic cases.

1881. Kartulis found the same organism in cases of Trachoma in Egypt.

1883. Koch showed that the bacilli described were the cause of a milder conjunctivitis and occurred in Trachoma as a superadded infection. These bacilli were afterwards known as the Koch-Weeks bacilli.

1891. Shongolowicz[39] found in the trachomatous conjunctiva a Gram-positive bacillus which is said to have produced Trachoma in animals.

1897. L. Müller[40] found in certain cases of Trachoma a bacillus resembling the influenza bacillus and the Koch-Weeks bacillus.

Inoculation experiments with these bacilli have not resulted in the production of Trachoma.

C. A Fungus infection of the conjunctiva.

1890. Noiszewski[41] found a fungus which he called the microsporon trachomatosum. But it has been shown that this has no significance in the production of the disease.

D. Protozoa in the conjunctiva.

1895. Krüdener found a plasmodium in the secretion and tissues in Trachoma. This was not present in follicular conjunctivitis.

1897. Burchard[42] found in epithelial scrapings of the conjunctiva bodies which he called coccidia which were oval in shape and non-nucleated. These bodies were proved to be not peculiar to Trachoma and inoculation experiments were negative.

1897. Czaplewski found in Trachoma follicles large amoeboid bodies.

1897. Elze[22] found in the discharge and follicles of a case of Trachoma motile plasmodia. There has been no proof that these were causal.

E. No organisms found in the conjunctiva.

1893. Mutermilch[11] failed to find any causal organism in Trachoma. He held that any inflammation might lead to Trachoma but that in itself Trachoma was not contagious.

Gunning of Amsterdam also failed to find any causal organism in chronic cases of Trachoma.

F. Non-pathogenic organisms in the conjunctiva.

1884. Da Gama Pinto)
) simply found a large number
1889. Reid... ... .) of non-pathogenic organisms.

1896. Cazalis[35] made a similar finding and held that the organisms of various forms of conjunctivitis under certain conditions with a suitable soil can produce Trachoma, follicles being a reaction of the tissues against infection.

G. A Mixed infection of the conjunctiva.

Tschmolôssow[12] in material expressed from the tissues in follicular conjunctivitis and Trachoma found Staphylococcus pyogenes aureus and albus nine times, Staphylococcus pyogenes citreus four times, and a short Löffler-like bacillus eight times.

1895. Scharl of Dorpat found twenty-four kinds of organisms in trachomatous discharge.

1897. Lawson[43] held that Trachoma was caused by a combination of organisms dependent on each other and virulent only when in combination.

H. Round Hyaline bodies in the deep layers.

Kastalsky found these in forty consecutive cases of Trachoma, and considered that they might be due to the chronic inflammatory nature of Trachoma or might be a reason for classifying Trachoma with the Granulomata.

I. A Filter-passing organism?

1901. Römer suggested that the cause may be a filter-passing organism. Axenfeld however denies this.

None of these investigations have resulted in conclusive evidence as to the causal organism of Trachoma.

VI. RECENT WORK.

A fresh impetus to research in Trachoma was given by the discovery of the Trachoma Corpuscles or Trachoma Bodies. What follows in the present section is a brief account of the more important work done in this new period.

The Trachoma Corpuscles.

Halberstadter and Von Prowazek[15] working in Java described bodies in the epithelial cells which they considered to be the cause of Trachoma. Granules appear in the cells: these multiply and separate from each other so that they form a ring, the initial body: inside this ring smaller granules appear which stain differently from the original granules, the elementary corpuscles. Gradually the nucleus is pushed to one side, the granules fill the cell and finally the cell ruptures and the corpuscle is free in the conjunctival secretion. These corpuscles were named Chlamydozoa by the Javan observers.

Greef of Berlin confirmed the discovery of these bodies in the trachomatous conjunctiva.

Lindner[44] described bodies which were said to accompany the Trachoma Bodies. Perhaps these were the original granules of Prowazek. They became known as Lindner's Initial Bodies.

Lowenstein[48] found Prowazek's enclosures in almost 100% of cases, both in fresh and old forms. Lowenstein is of the opinion that the difficulty of technique in the obtaining of material is responsible for the failure of other observers to find these except in a small proportion of cases. He also found that the enclosures are frequently associated with Koch-Weeks bacillus.

Cell Inclusions in non-trachomatous conditions.

A. Ophthalmia Neonatorum and Gonorrhoeal Conjunctivitis.

Heymann[44] described the discovery of structures similar to the Trachoma Corpuscles in cases of ophthalmia neonatorum where gonococci were absent. This condition has come to be known as Inclusion Blenorrhoea. The cases are non-specific cases of ophthalmia neonatorum, characterised by the presence of cell-inclusions very similar to those found in Trachoma. They are not trachomatous: pannus and cicatricial changes are not produced and on inoculation of the secretion into another conjunctiva blennorrhoea is produced, not Trachoma.

Stargart also claimed to have found cell-inclusions in ophthalmia neonatorum.

Then it was said that the structures were isolated from the vagina in mothers of infants suffering from such ophthalmia.

They were also found in the urethral secretion of men suffering from gonorrhoeal urethritis.

This seemed to establish a close relationship between Trachoma and these other conditions, and it was thought that the cell-inclusions might be characteristic of a hitherto unrecognised venereal disease.

Herzog[45] in 1910 threwdoubt on the theory of a new venereal disease and stated that Trachoma bodies were involution forms of the gonococcus.

He claimed to have produced similar bodies by the prolonged cultivation of a pure gonococcus culture. Also he found typical Trachoma bodies in the secretion of gonococcal conjunctivitis when the acute stage had passed off. He inoculated a conjunctiva with a pure gonococcal culture from a urethritis and after 14 days found the typical Trachoma bodies in the secretion.

In a fresh case Herzog found intra cellular organisms which appeared to be transitional forms between the typical gonococcus and the Trachoma corpuscles. Herzog's work has not been confirmed.

Flemming[24] described four different types of Trachoma corpuscle, of which he considered two only as positive. He found them associated with gonococci repeatedly in ophthalmia neonatorum. In one for the first few days only Trachoma bodies were found and after the fifth day gonococci and cell-inclusions were present for several days. Then the Trachoma bodies disappeared. Gonococci remained in the secretion for ten weeks and were then finally replaced by the Trachoma bodies.

B. Other Conditions of the Conjunctiva.

1. The early stages of the corpuscles have been found in the normal conjunctiva.

2. Erdmann[44] found them present in certain cases of chronic catarrhal conjunctivitis.

3. Leber[15] described cell-inclusions in the condition known as Desquamative Epitheliosis. This is caused by the Cytozoon atrophicans and clinically resembles Trachoma.

C O N C L U S I O N S.

The Trachoma Corpuscle is of obscure origin and is varied in its morphology. Opinions differ as to whether it is a parasite or microorganism or a degenerate cell.

Some observers like Walker[44] hold the latter view, stating that Trachoma is not an entity but is simply the pathological expression of the reaction of the conjunctiva to various irritants. This may be true of some elements in Trachoma such as the increass in lymphoid tissue which is found also in follicular conjunctivitis

and atropine catarrh. But the contagiousness of Trachoma seems to disprove any more elaborate view of this sort.

Noguchi and Cohen[15] claim to have cultivated the Trachoma corpuscle outside the body and this disposes of the theory that the Chlamydozoon is a degenerate cell.

Axenfeld[44] states that Trachoma bodies are found in the conjunctiva only and are probably not cell products nor metamorphosed gonococci nor products of mucoid degeneration.

The exact nature of the Trachoma corpuscles is unknown. But the consensus of opinion seems to be that they are pathogenic organisms with a diagnostic significance in Trachoma, as they are not so frequently found in other conditions.

VII. ORIGINAL OBSERVATIONS ON TWENTY CASES OF TRACHOMA.

A. Nature of the Observations and the Methods Adopted.

The work was carried out in twenty consecutive cases attending hospital for Trachoma. There was no choosing of cases. Some were early cases of the disease, some were in the late cicatricial stage while most were in the more contagious secondary stage with pannus formation. All, however, were definitely cases of Trachoma, diagnosed as such by the honorary staff of the Royal Eye Hospital, Manchester.

The three chief points investigated were:-

1. The Presence or Absence of Spirochaetes in the Conjunctiva.

Taking into account the facts that -

(a) Trachoma had been attributed to so many different organisms.

(b) No organisms had been proved to be the exciting cause.

(c) No record was available of any search having been made for spirochaetes

it seemed desirable to examine specimens systematically for spirochaetes. In each case the upper lid was everted and scrapings were taken from the palpebral conjunctiva and the retrotarsal fold, care being taken as far as possible to obtain serum and surface epithelium without causing bleeding.

The scrapings were teased out in saline solution on two slides.

a. One slide was fitted with coverslip and examined at once for spirochaetes by Dark Ground Illumination. According to the Medical Research Committee's special report[46] this is the ideal method for the demonstration of spirochaetes. By this method characteristic spirochaetal movement can be seen, and also the distortion caused by drying is avoided.

Working with a Leitz dark ground condenser, and Pointolite lamp, the light is first of all centred with no optical appliance in the microscope. The next step is to slip the dark ground illuminator into the substage. Then a low power objective is placed in the microscope and the slide on the stage, having previously put a large drop of cedar wood oil on the top of the dark ground illuminator: the latter is carefully racked up until the gap between the slide and condenser is filled with oil and on examination with low power lens the maximum concentration of light in the centre of the field is obtained, this light being centred by the centreing screws on the condenser. An oil immersion objective is now substituted for the low power, the latter being unscrewed to make room for the former, so as to avoid interference with centreing.

Care is taken to use slides of the one thickness which is found suitable. Also absolute cleanliness of slides and cover glasses must be maintained, and the immersion fluid must be free from air bubbles.

b. The second slide was treated by Fontana's silver nitrate method. The film was covered with Huge's fluid, (Ic.c. acetic acid, 20 c.c.formalin, 100 c.c. distilled water) and flooded several times with the fluid. It was washed later in water and then covered with 5% Tannic acid in 1% carbolic acid and heated for thirty seconds. After washing in water the film was treated with the silver solution, prepared by adding a trace of ammonia to a 0.25% solution of silver nitrate in distilled water. Heat was applied for thirty seconds and the film then washed and dried. Each film was examined with oil immersion objective.

2. A COMPLETE BLOOD COUNT.

a. The Haemoglobin was estimated by Haldane's modification of Gowers' Haemoglobinometer.

b. The Red Cells were enumerated by the Thoma-Zeiss Haemocytometer. The diluting fluid used was 0.9% sodium chloride with 1% Formol and made up with distilled water.

c. The Colour Index was calculated.

This was done in each case so as to give some reliable indication as to the general condition of the patients, and whether Trachoma was associated with lowered vitality and diminution in Red Cell and Haemoglobin count.

d. The White Cells were counted by the Thoma Zeiss Haemocytometer. The diluting fluid used was 2% acetic acid in distilled water coloured with methyl violet. By this means one hoped to get an indication that Trachoma is an infection.

e. A Blood Film was made in each case stained with Leishman's stain and 500 cells were counted so as to obtain the percentages of the different varieties of cells. By this Differential Count one hoped to obtain some clue as to whether the cause might be bacterial, where one might get a polymorph leucocytosis, or protozoal, when a lymphocytosis might be present.

3. THE EFFECT OF TREATMENT BY CONJUNCTIVAL INSTILLATION OF NOVARSENOBILLON.

Should spirochaetes be found in the conjunctiva a favourable result with Novarsenobillon might possibly be corroborative proof that the spirochaete was the exciting cause of Trachoma.

About five drops of a solution of a 10% solution of Novarsenobillon in distilled water was dropped into the conjunctival sac at varying intervals. The usual precautions were taken, particular care being shown in using the solution freshly made up and before oxidation occurred.

4. In addition the <u>following Schedule</u> was drawn up to help in elucidating the predisposing causes and as an aid in drawing conclusions.

Name.

Age.

Address.

Occupation.

Nationality.

Date and mode of onset.

Any history of contagion in the case.

Present stage of disease.

Date of first treatment and nature of treatment.

Any gonorrhoeal history or history of previous disease.

B.1. DETAILS OF RESULTS.

CASE No.	a. DARK GROUND.	b. FONTANA.
1.	Granules showing Brownian movement, no spirochaetes.	No spirochaetes.
2.	Floating debris. No spirochaetes.	"
3.	No spirochaetes.	"
4.	"	"
5.	"	"
6.	Artefact shreds of debris of spirillary form. No spirochaetes.	"
7.	No spirochaetes.	"
8.	"	"
9.	"	"
10.	"	"
11.	"	"
12.	"	"
13.	"	"
14.	"	"
15.	"	"
16.	"	"
17.	"	"
18.	"	"
19.	Artefact streamers seen from Erythrocytes.	"
20.	"	"

2.

Case No.	(a) R.B.C.	(b) Haemo-globin.	(c) Colour Index.	(d) Leu-cocytes.
1.	4,860,000	82%	0.85	9,400
2.	4,920,000	80%	0.81	10,000
3.	4,960,000	80%	0.8	11,400
4.	4,120,000	60%	0.7	9,000
5.	3,800,000	52%	0.68	8,200
6.	4,630,000	74%	0.78	9,800
7.	5,000,000	90%	0.9	9,200
8.	4,860,000	70%	0.7	9,200
9.	5,520,000	90%	0.8	10,400
10.	4,600,000	74%	0.8	10,200
11.	4,200,000	64%	0.7	9,800
12.	4,160,000	72%	0.8	9,600
13.	4,800,000	80%	0.8	10,600
14.	4,800,000	70%	0.7	9,000
15.	4,200,000	80%	0.9	9,600
16.	4,800,000	90%	0.9	9,800
17.	4,410,000	62%	0.7	9,200
18.	4,630,000	88%	0.9	8,400
19.	4,750,000	82%	0.8	9,800
20.	4,650,000	78%	0.8	8,400

2.

DIFFERENTIAL COUNT PERCENTAGE.

Case No.	Polymorphs.	Small Lymphos.	Large Lymphos.	Hyaline.	Eosinophil.	Mast Cells.
1.	57.6	35	3.8	1.2	1.6	0.8
2.	65	26.6	3.8	2	2.4	0.2
3.	63	29	4	2.2	1.4	0.4
4.	62.4	28.2	5.8	1.2	2	0.4
5.	54	35.2	7	1.6	1.8	0.4
6.	58	31	7	1.8	2	0.2
7.	51.2	37.8	7	2	1.4	0.6
8.	61	31	5	1	1.2	0.8
9.	56.4	35.2	3.8	2	2	0.6
10.	47.2	44.8	5	1	1.2	0.8
11.	46	44	7	1.6	1	0.4
12.	52	38	6.2	1	2	0.8
13.	47.8	42.2	6	1.4	2	0.6
14.	55.4	33	9	0.8	1.2	0.6
15.	54	35	6	2.4	2.2	0.4
16.	51.4	40.6	5	1.2	1.2	0.6
17.	54	36	7	1.8	1	0.2
18.	54.6	34	7	2	1.8	0.6
19.	53	37	7	1.8	1	0.2
20.	53	34.4	8.2	1.2	2.4	0.8

3. INSTILLATION OF NOVARSENOBILLON.

Case No.	Dates of Instillation.	Remarks.	Conclusions.
1.	30.6.21. 7.7.21. 14.7.21. 21.7.21. 28.7.21. 4.8.21 11.9.21. 25.8.21.	Reports no difference. Conjunctiva paler. Less secretion. Conjunctiva paler. Left pannus marked.	The drops were followed by less congestion of palpebral conjunctiva. Afterwards pannus gave rise to irritation.
2.	30.6.21. 7.7.21. 14.7.21. 21.7.21. 28.7.21. 4.8.21.	Right corneal Ulcer. Pain for two days, then better. No improvement. Instillation causes pain.	A case with corneal ulcer, which showed no improvement.
3.	30.6.21 7.7.21. 14.7.21. 28.7.21. 4.8.21. 18.8.21. 1.9.21. 8. 9.21.	 Reports less discharge. Claims improvement. Conjunctiva paler. Reports much improvement for four days after drops. " " "	Conjunctiva became paler and discharge less. The effect was repeatedly of four days duration.

4.	30.6.21. 7.7.21. 14.7.21. 21.7.21. 28.7.21. 4.8.21. 11.8.21. 25.8.21. 8.9.21. 15.9.21.	Claims improvement. " Less discharge. Conjunctiva paler. Claims improvement. " " " " "	Showed improvement. In common with several others would not attend for ordinary treatment, but showed enthusiasm for Novarsenobillon.
5.	7.7.21. 14.7.21. 28.7.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	Claims improvement. " " Conjunctiva paler. Claims improvement. Better immediately after drops.	Improvement shown by pallor of ~~pallor of~~ conjunctiva. An old standing case claiming improvement for about four days, then effect wears off.
6.	7.7.21. 14.7.21. 21.7.21. 28.7.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	Conjunctiva paler.	Old standing cicatricial case. A little more comfortable after drops.

7.	22.7.21. 28.7.21. 8.9.21. 15.9.21.	States better able to open eyes after drops.	Was definite as to improvement. Owing to domestic trouble did not attend regularly.
8.	22.7.21. 28.7.21. 4.8.21. 11.8.21. 8.9.21. 15.9.21.	Conjunctiva paler. Claims improvement. Owing to illness unable to come before.	Stated she could see more clearly for four days after drops.
9.	22.7.21. 28.7.21 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	Not so much secretion. Claims improvement. Much better especially for first four days after drops. Gives ease and silky feeling for four days.	An early case where congestion was reduced and roughness and discharge diminished.

10.	26.7.21. 28.7.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	Claims improvement. Less discharge. "Much better" Opens eye better.	Some improvement but she neglected atropine treatment for pannus and made improvement seem less.
11.	26.7.21. 28.7.21. 29.7.21. 2.8.21. 4.8.21. 11.8.21. 18.8.21.	Reports eye more comfortable. Conjunctiva paler.	Very marked pannus and blepharospasm. No great degree of improvement
12.	26.7.21. 28.7.21. 2.8.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	 Less discharge. Eyelids not so heavy. Not so much improved as when drops were given more frequently.	Improved on frequent instillation An old standing case.

13.	26.7.21. 28.7.21.		A youngster who did not attend sufficiently.
14.	28.7.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	Claims to be more comfortable.	An old standing cicatricial case. Did not show any change.
15.	28.7.21. 2.8.21. 4.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21. 8.9.21. 15.9.21.	"Much better". Conjunctiva paler. Less discharge.	An early case, showing improvement and better for about four days after the drops.
16.	28.7.21. 4.8.21. 11.8.21.	Eyelids less swollen.	Did not attend enough to enable definite conclusions to be drawn.

17.	4.8.21. 5.8.21. 11.8.21. 18.8.21. 25.8.21. 1.9.21.	Not so much secretion. Eye more comfortable.	Very thick pannus not affected. Eye more comfortable.
18.	4.8.21. 5.8.21. 11.8.21. 18.8.21. 25.8.21.	Comfortable to-day for the first time for a fortnight. Less discharge and conjunctiva paler.	An early case which benefited.
19.	11.8.21.		An early case, only one appearance.
20.	25.8.21.		Only one appearance.
21.	1. 9.21. 8. 9.21.	More comfortable, paler and less discharge. Effect wore off to some extent, after 4-5 days.	Definite improvement.

22.	1.9.21. 8.9.21. 15.9.21.	Conjunctiva paler.	Improved.
23.	1.9.21. 8.9.21. 15.9.21.	Neglected using atropine for pannus. Better.	No definite conclusion.

Case No.	Name.	Age.	Occupation.	Address.	Nationality.	Onset.
I.	Philip B.	60.	Nil.	Cheetham, Manchester.	Jewish.	1881. Russian Army.
2.	Annie B.	43.	House duties.	Manchester.	Jewish.	Left Eye 1908. Rt. 1917.
3.	Arthur H.	23.	Ex-Soldier.	Failsworth.	English.	March 1918. Brit. Labour Bn. Battal. in France.
4.	John L.	20.	Newsvendor.	Manchester.	Jewish.	Babyhood.
5.	Ada W.	38.	Office cleaner	Salford.	English.	Babyhood.
6.	Hilda P.	62.	Housework.	Kersal.	Jewish.	1906. In Russia.
7.	Michael M.	25.	Labourer.	Manchester.	Irish.	Weak eyes as boy. Fresh outbreak 1918 at Scarboro' while training with Lancs. Fusiliers.
8.	Mary D.	23.	Dry Cleaner.	Patricroft.	Irish.	Rt. bad at school in Ireland. Fresh attack 1920.
9.	John P.	31.	Ex-cogger at Mill.	Gorton, M/c.	English.	1921. Worked in dusty atmosphere with sore eyed Irish labourer.
10.	Emma R.	17.	Cardroom Worker	Droylsden.	English.	Since infancy at Poor Law Schl.
11.	Margaret M.	14.	Schoolgirl.	Hulme, M/c.	Irish.	1919.
12.	Sarah B.	22.	Shorthand Typist.	Cheetham M/c.	Jewish.	1904.
13.	William C.	13.	Schoolboy.	Ancoats, M/c.	English.	Left 1919.
14.	Maggie K.	37.	House duties.	Manchester.	Lithuanian.	20 years ago.
15.	May K.	27.	House duties.	Manchester.	Irish.	Left in 1921 after a visit to Berlin.
16.	Jessie F.	29.	Clerk.	Cheetham, M/c.	English.	Sept. 1919.
17.	Nellie C.	15.	Nil.	Irlamso'th'Hgt.	English.	1914 at Poor Law School.
18.	May C.	21.	Domestic.	Manchester.	English.	1921.
19.	James B.	14.	Piecer.	Heywood.	English.	1921.
20.	Annie K.	18.	Mil.	Miles Platting.	Irish.	In childhood at Poor Law School.
21.	John G.	21.	Traveller.	Hightown, M/c.	Jewish.	1904.
22.	Violet D.	15.	Nil.	Didsbury.	Irish.	1910.
23.	Theresa H.	42.	House Duties.	Ancoats, M/c.	Irish.	1909.

Case No.	History of Contagion.	Date of First Treatment.	Present Stage.	Previous History.
1.	Caught from other soldiers. No family infection.	1881. Usual.	Bilateral Cicatrising. marked left pannus.	No previous disease. No gonorrhoea.
2.	No history of C. obtained.	1908. Usual and CO_2 Snow.	Left eye cicatricial Rt. " hypertrophic and severe ulcer of cornea.	None.
3.	Working near Chinese when contracted. A brother has caught Trachoma.	1918. Usual and Expression.	Rt. Hypertrophy and Pannus. Lft. Unaffected.	None.
4.	No history of C. obtained.	Soon after beginning.	Cicatricial. Pannus Left.	Not known as regards ophthalmia neonatorum.
5.	Younger sister caught Trachoma.	" "	" "	None.
6.	No such history obtained.	Not known.	Cicatricial. Pannus and Entropion Left.	None.
7.	None obtained.	1918.	Hypertrophy, Rt. Pannus.	None.
8.	Got from children at school in Ireland	1921.	Rt. Pannus.	None.
9.	Got from labourer. Turned back from America.	1921.	Hypertrophy both eyes.	Conjunctivitis from dust.
10.	Two sisters have Trachoma. Got it at Poorhaw School.	1907.	Hypertrophy both eyes.	None.
11.	None.	1919.	Hypertrophy and Pannus.	Scrofulous.
12.	Sister has caught Trachoma.	1904.	Early cicatricial.	None.
13.	None.	1921.	Unilateral Hypertrophic.	None.
14.	One son has caught Trachoma.	Not known.	Trichiasis and Entropion.	None.
15.	None.	1921.	Unilateral Hypertrophic.	None.

16.	None.	1919.	Hypertrophic.	None.
17.	Caught at Poor Law School. Brother has caught it.	1914.	Rt. Pannus marked. Left. cicatricial.	None.
18.	None.	1921.	Unilateral Hypertrophy.	None.
19.	None.	1921.	Hypertrophy and Pannus.	Phylyctenular Disease.
20.	Caught at Poor Law School.	Not known.	Pannus.	None.
21.	Brother caught Trachoma.	Not known.	Pannus.	None.
22.	None.	" "	Pannus.	None.
23.	Got from Baby.	1909.	Pannus.	None.

SUMMARISED RESULTS.

1. The Search for Spirochaetes.

Two slides were examined from each of the twenty cases one by the Dark Ground method, the other by the Fontana method, and no spirochaetes could be found in any of them. Blood streamers were seen occasionally and artefacts of spirillary form. But the results in this section were definitely negative.

2. Blood Count.

a. Red Blood Corpuscles.

The average number in the twenty cases were 4,633,000.

b. Haemoglobin.

The average percentage in the twenty cases was 75%.

c. Colour Index.

The average colour index was 0.79.

d. Leucocytes.

The average white count in the twenty cases was 9,550.

e. Blood Film.

The average differential count was:-

Polymorphonuclears	54.85%
Small Lymphocytes	35.40%
Large "	6.03%
Hyaline cells	1.56%
Eosinophile	1.64%
Mast cells	0.52%

3. The Instillation of Novarsenobillon Solution.

Out of 23 cases where Novarsenobillon was used no conclusion could be obtained as to results in five cases. Nos. 13, 16, 19, 20, 23.

The eighteen others received an average of about seven instillations each into the conjunctival sac. These were usually given once weekly but on a few occasions were given

pn alternate days. No harmful results were found. In one case with corneal ulcer pain was produced by the drops and they were finally discontinued. The majority of cases showed decided improvement under the treatment. The objective results seen were:-

a. A much paler conjunctiva with diminution in swelling.

b. Less secretion.

The subjective results noticed by the patients were:-

a. Less itching.

b. A silky feeling instead of roughness of lids.

c. Less running from the eyes.

d. Eyes open more easily.

e. Lids not so heavy.

The sister in charge of out-patients reported that enthusiasm was shown in attending for Novarsenobillon while there was difficulty in getting attendance for ordinary treatment.

The cases which did not benefit were those with marked corneal affections in an irritable stage or those in an advanced cicatricial stage.

4. Predisposing Causes etc.

Sex. Eight out of twenty three cases were males.

Age. The average age was twenty six years.

Occupation. Six over school age had no occupation owing to Trachoma. I.3.9.17.20.22.

Six did housework.

Two were of school age.

Two were soldiers in the late war, one of whom contracted Trachoma in the army, while the other claimed to have done so but quite possibly had Trachoma when he entered the army.

One had served and contracted Trachoma in the Russian army, Case 1.

One worked and contracted Trachoma in a dusty atmosphere.

Case 9.

Address. All were from areas around Manchester.

Nationality.

Six were Jews.

Seven were Irish.

One Lithuanian.

Nine claimed English nationality.

Mode of Onset.

Two cases were said to have begun in babyhood. Cases Nos. 4 & 5.

Six " " " " " " at school, 7,8,13, 19.12. & 11.

Three " " " " " " at Poor Law Schools. 10,17, 220.

Two " " " " " " in infancy at home. 21 & 22.

One case was " " " " Poor Law Infirmary. 23.

" " " " " " " in Germany 15.

" " " " " " " " Lithuania. 14.

" " " " " " " " Russian Army. 1.

" " " " " " " " Russia 6.

" " " " " " " " France during war, while near Chinese troops. 3.

Other cases could give no account.

Duration.

Three cases under one year.

Three cases about two years.

One case three years.

One case twenty years.

One case forty years.

Other cases were between these extremes.

- - - - - - - -

History of Contagion.

Eight cases gave histories of developing the disease by contagion.

Seven " " " " having transmitted the disease to others.

Date of first treatment.

Varied from the same day as the examination up to forty years ago.

Present stage of disease.

Four cases were unilateral.

Eight cases were in the cicatricial stage.

In thirteen cases the pannus was a prominent feature.

In eleven cases hypertrophy was a prominent feature.

Three cases had marked pannus in a very irritable condition i. 11. 17.

One had corneal ulcer. 2.

History of gonorrhoea or other previous disease.

Case No. 4. might have had ophthalmia neonatorum but no evidence was found.

" " 8. Had irritation and conjunctivitis from dust.

" " 11. was a girl of the scrofulous type.

" " 19. was said to have been treated at school for phlyctenular disease.

VIII. SUMMARY AND CONCLUSIONS.

Researches into the aetiology of Trachoma have been shown to be important so as to

1. Encourage Prophylaxis.
2. Facilitate early diagnosis and thus avoid invasion of this country by Trachomatous immigrants.

From the historical study of the disease it has been seen that Trachoma is an old established disease, of world wide distribution which may break out in epidemics particularly in armies and schools and which may be hampered in its spread by taking proper precautions.

In the section on the early views as to aetiology it has been shown that the contagiousness of the disease became universally recognised. After many more fantastic theories as to the cause had been propounded Trachoma came to be regarded as due to a virus transmitted by the conjunctival secretion. Transmission was held to be most likely to occur when predisposing conditions were present preparing a nidus for or facilitating infection.
The most important predisposing causes were shown to be:- Want of cleanliness, overcrowding, unfavourable occupational conditions, war service, school attendance, with its lack of care in avoiding contagion, and debilitating disease.
Since the beginning of the search for the causal organism about thirty years ago many claims have been made that the organism was discovered. No proper confirmation however has been given to any work claiming a specific organism as the cause, nor were any very promising results obtained until the discovery of the Halberstädter-Prowazek bodies. These are regarded as pathogenic organisms of diagnostic significance in Trachoma but they are not yet proved to be the cause.

Researches with various organisms as possible causes for Trachoma having proved inconclusive, for the purpose of this Thesis observations were made as to the possibility of the causal organism being a spirochaete.

The results obtained have been:-

1. The causal organism is not a spirochaete. Careful examination of specimens by two different methods a. Dark Ground, b. Fontana films, failed to show apirochaetes.
2. Examination of the Red Blood Count, Haemoglobin percentage and Colour Index showed that Trachoma is associated with Anaemia and lowered vitality.
3. Examination of the white cell count tended to show that Trachoma is an infection, a leucocytosis being obtained.
4. A differential count of the Leucocytes in Blood Films showed an increase in the Lymphocytes indicating that the casual organism is most likely to be a protozoon. If the Halberstädter-Prowazek bodies be taken as the cause this may be an indication as to the true nature of the bodies.
5. Though no spirochaetes were found the majority of the cases seemed to improve under treatment by instillation of a solution of Novarsenobillon into the conjunctival sac. The explanation of this may be that the arsenical preparation acts in this case not by toxic effect on any spirochaete but by a stimulating action on the tissues, or by a lethal action on any other parasite.

The results obtained were sufficiently encouraging for one to suggest this as a method of treatment for Trachoma.

The strength should be 0.3 grm. to 3 cc. distilled water and the interval between instillations not longer than three to

four days. The cases in which its use is contraindicated are those in an advanced cicatricial stage and those with severe irritable corneal conditions.

6. The enquiry showed that the predisposing conditions previously enumerated are of importance in the dissemination of the disease.

I wish to express my indebtedness to Dr. Arnold Renshaw, Bacteriologist to the Manchester Royal Eye Hospital whose methods were followed, and to the Staff of the Hospital, by whose kind permission the work was undertaken and in whose laboratory it was conducted.

IX. BIBLIOGRAPHY.

1. Parsons... ... Transl. of Boldt's Trachoma. London. 1904.
2. Collins... ... Ibid.
3. Nettleship.... Report on Ophthalmia in Metropolitan Schools. 1875.
4. Stephenson ... Report on Metropolitan Poor Law Schools. 1897.
5. Vetch... . ... Report on Ophthalmia 1807.
6. Rust... .. ... Die aegyptische Augenentzundung. Berlin. 1820.
7. Graefe.C.F.... Die epidemisch-Kontagiöse Augenblennorrhoe 1823.
8. Decondé... ... Memoires) Brussels 1841.
9. Larrey.... ... Memoires sur l'ophthalmie Paris. 1803.
10. Baltz. ... ... Utrecht. 1822.
11. Mutermilch.... Annales d'Oculistique. 1893.
12. Burnett... ... Norris and Oliver's System of Ophthalmology.
13. Baeck... . ... Scrofula and Trachoma, Munch.Med.Woch. 1900.
14. Stephenson ... Epidemic Ophthalmia. 1895.
15. Fuchs... . ... Text book of Ophthalmology. 1917.
16. Graefe.. . ... Loc Cit.
17. Burnett... ... Loc Cit.
18. Stephenson ... Epidemic Ophthalmia.
19. Yarr... .. ... Trachoma and Race. Brit.Med.Journ.1899.
20. Raehlmann. ... Nosologie des Trachoms.Klin Jahrb.Bd IX.
21. Ziehm. ... ... Zur Lehre vom Trachom. Wien klin Woch.1900
22. Elze.. ... ... Uber Plasmodienfunde bei Trachom.Zwickau. 1897.
23. Hourmouziades. De la conjunctivite granuleuse. Paris.1902.
24. Crigler... ... Trachoma. Journ.A.M.A. March 1912.
25. Lucanus... ... Untersuchungen. Diss. Marburg. 1890.
26. Scott. ... ... Eye disease in Egypt. Lancet.II.1900.
27. Feuer. ... ... Die Verbreitung des Trachoms in Ungarn. Stuttgart. 1897.

28. Boldt... ... Trachoma. Transl.by Parsons and Snowball. London. 1904.

29. XII Congress internat. VI. 121.

30. Sattler. ... Uber die geographische Verbreitung des Trachoms X Internat.Med.Kongr.Berlin. 1891.

31. Ebert... ... Zur Trachomfrage, Vienna. 1898.

32. Kuhnt... ... Uber die Therapie der Conjunctivitis Granulosa. Jena. 1897.

33. Matkovic.... Contagion et therapie du Trachome. Rec. d'Ophth. 1898.

34. Blumberg. Uber das Trachom V.Graefe Archiv.Bd. XV. 1869.

35. Cazalis. ... Etude bacteriologique. 1895.

36. Peters.. ... Munch med.Woch. 1903.

37. Von Michel.. Arch. f. Augenh. 1896.

38. Hirschberg and Krause. Centralbl f.prakt.Augenheilk. 1881.

39. Shongolowicz. St.Petersb. med. Woch. 1891.

40. L.Muller. Arch.f.Augenheilk. Bd. XL. 1900.

41. Noiszewski. Centralbl. f. prakt Augenheilk. 1890.

42. Burchardt. " " " " 1897.

43. Lawson. Royal London Ophth. Hosp. Rep.1897.

44. De Schweinitz. Diseases of the Eye. 1917.

45. Herzog Deut. med.Woch. [illegible]. June 9th. 1910.

46. Med.Research Committee, Special Report, Series No.19. 1918.

47. Lister. The Trachoma Problem. Journ. R.A.M.C. 1919. XXXII.

48. Lowenstein. Uber die Aetiologie des Trachoms. Med. Klin. Berlin. 1918. XXXIV. 1129.